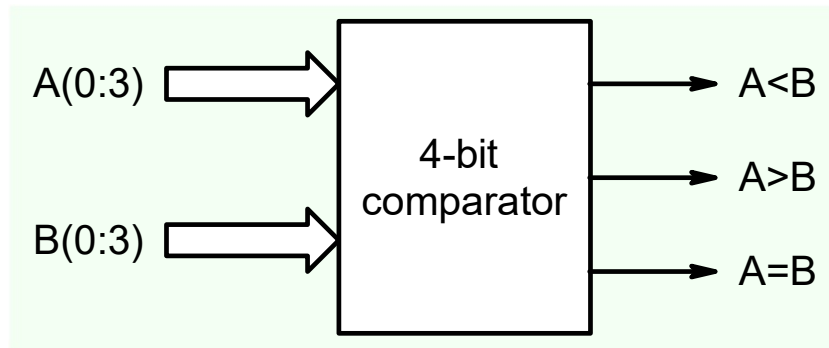


# ESC201T : Introduction to Electronics

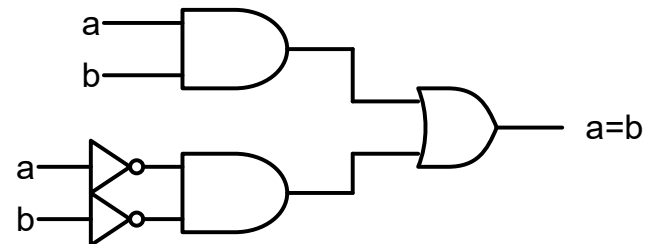
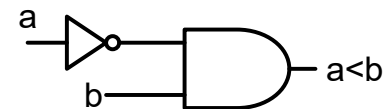
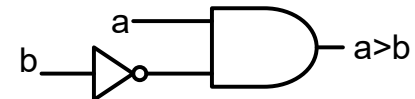
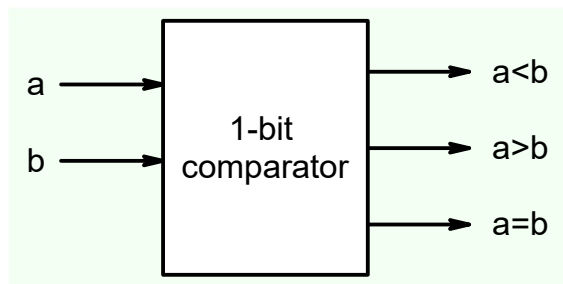
## Lecture 36: Combination circuit-3

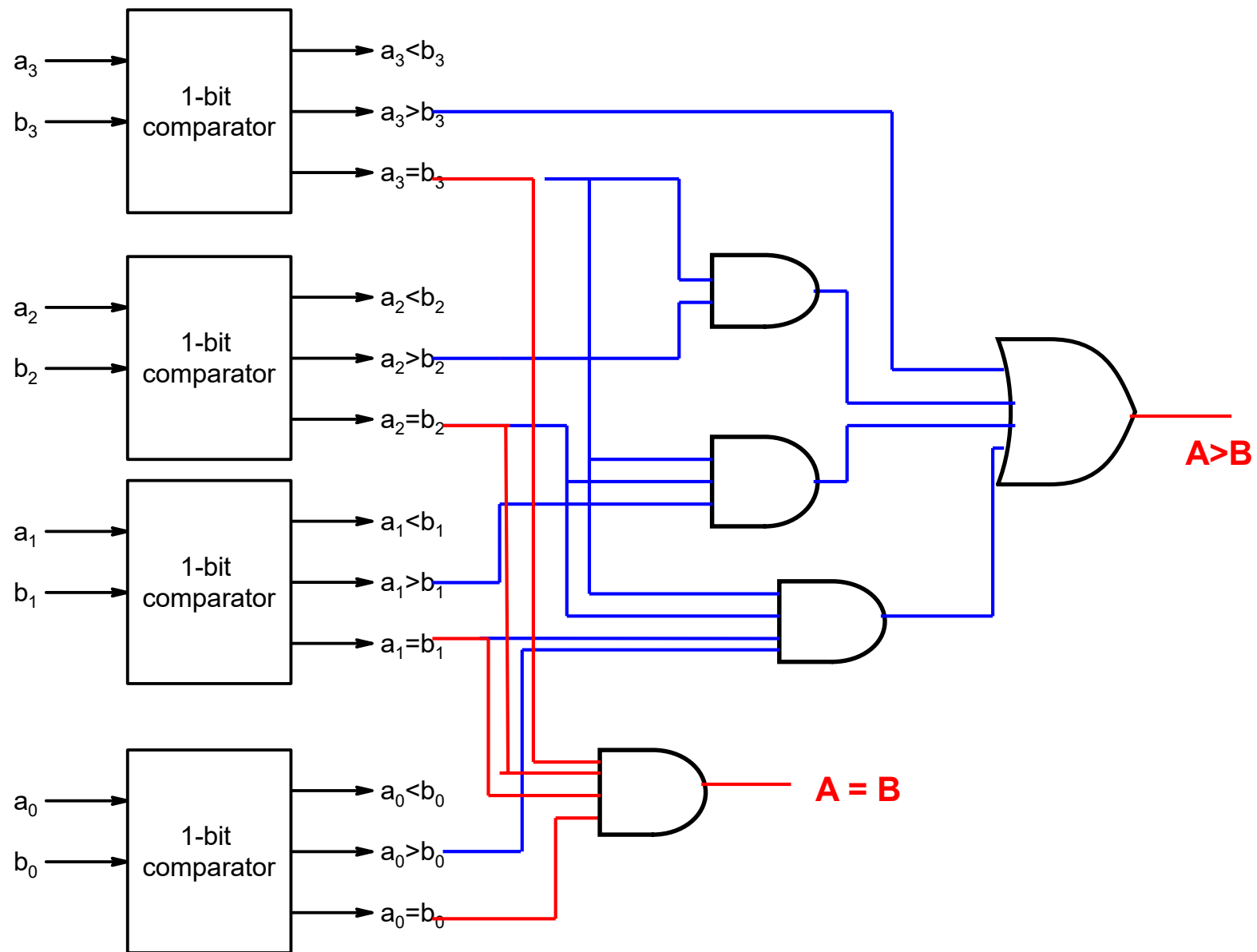
B. Mazhari  
Dept. of EE, IIT Kanpur

## Comparator

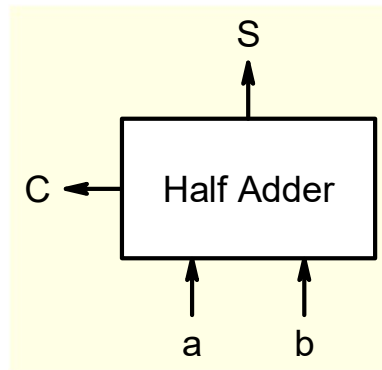


$A_3A_2A_1A_0$	$B_3B_2B_1B_0$	$A < B$	$A > B$	$A = B$
0000	0000	0	0	1
0000	0001	1	0	0
0001	0000	0	1	0
⋮	⋮	⋮	⋮	⋮

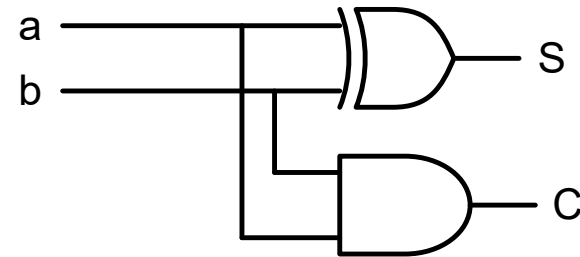




## Adder/Subtractor

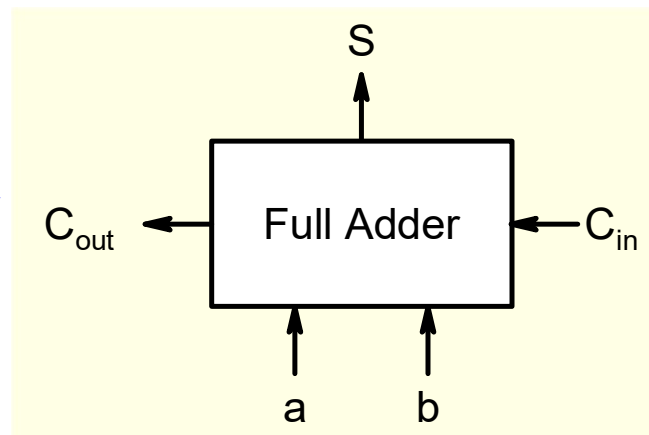


$a$	$b$	$S$	$C$
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1



$$S = \bar{a}.b + a.\bar{b}; C = a.b$$

$\overset{1}{1} \ 1 \ 1$   
 $\underline{1 \ 1 \ 0}$   
 $1 \ 1 \ 1 \ 1$



$a$	$b$	$C_{in}$	$S$	$C_{out}$
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

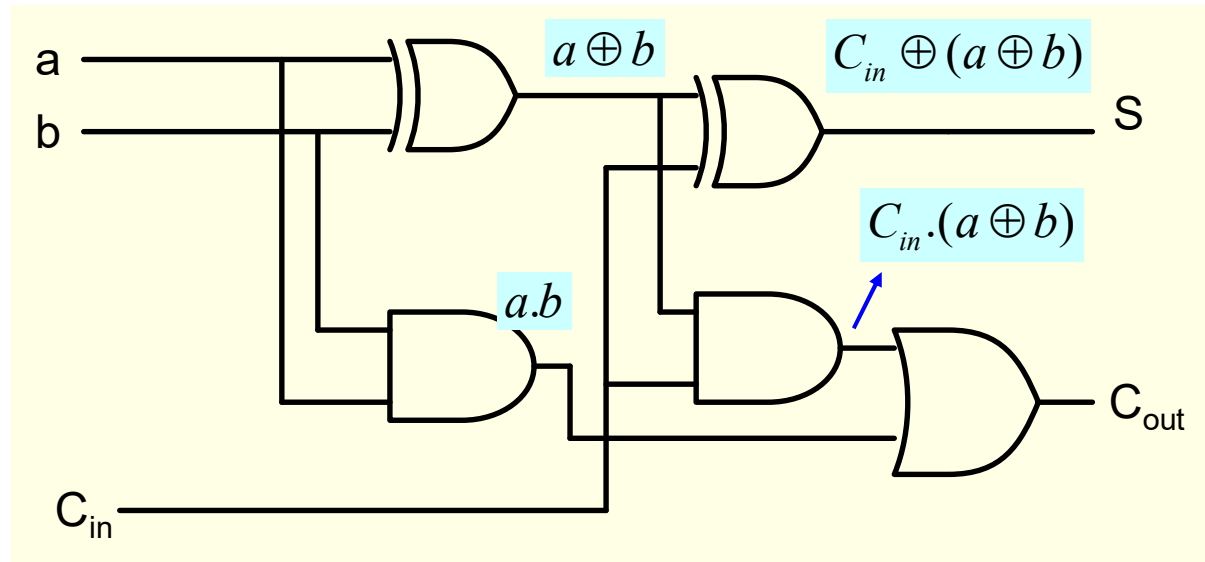
$$S = \bar{a}.\bar{b}.c_{in} + \bar{a}.b.\bar{c}_{in} + a.\bar{b}.\bar{c}_{in} + a.b.c_{in}; C_{out} = a.b + a.c_{in} + b.c_{in}$$

$$S = \bar{a}\bar{b}c_{in} + \bar{a}b\bar{c}_{in} + a\bar{b}\bar{c}_{in} + ab c_{in}$$

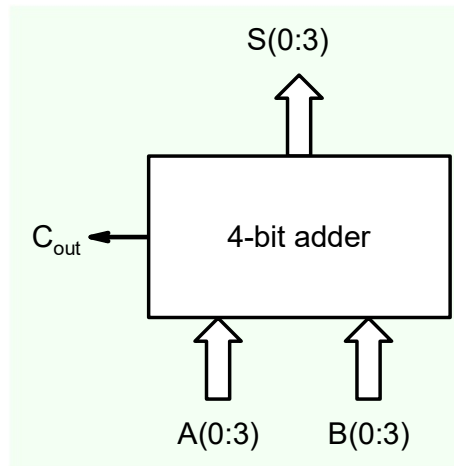
$$S = C_{in} \oplus (a \oplus b)$$

$$C_{out} = a.b + a.C_{in} + b.C_{in}$$

$$C_{out} = C_{in}(a.\bar{b} + \bar{a}.b) + a.b = C_{in} \cdot (a \oplus b) + a.b$$

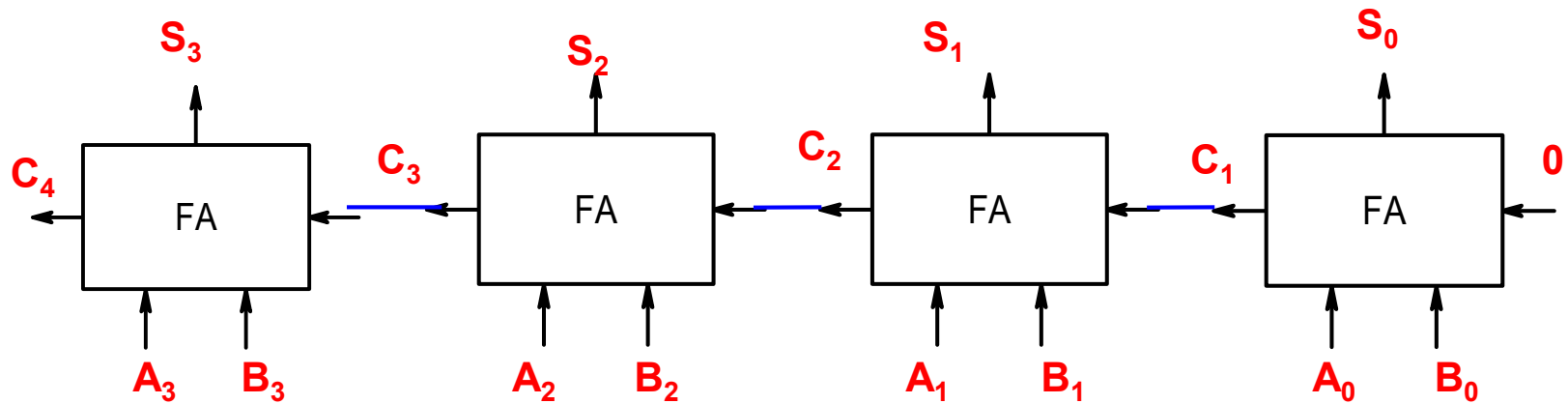


## 4-bit Adder



$A_3 A_2 A_1 A_0$	$B_3 B_2 B_1 B_0$	$S_3 S_2 S_1 S_0$	$C_{out}$
0000	0000	0000	1
0000	0001	0001	0
0001	0000	0001	0
⋮	⋮	⋮	⋮

$$\begin{array}{r}
 C_3 C_2 C_1 \\
 A_3 A_2 A_1 A_0 \\
 B_3 B_2 B_1 B_0 \\
 \hline
 C_4 S_3 S_2 S_1 S_0
 \end{array}$$



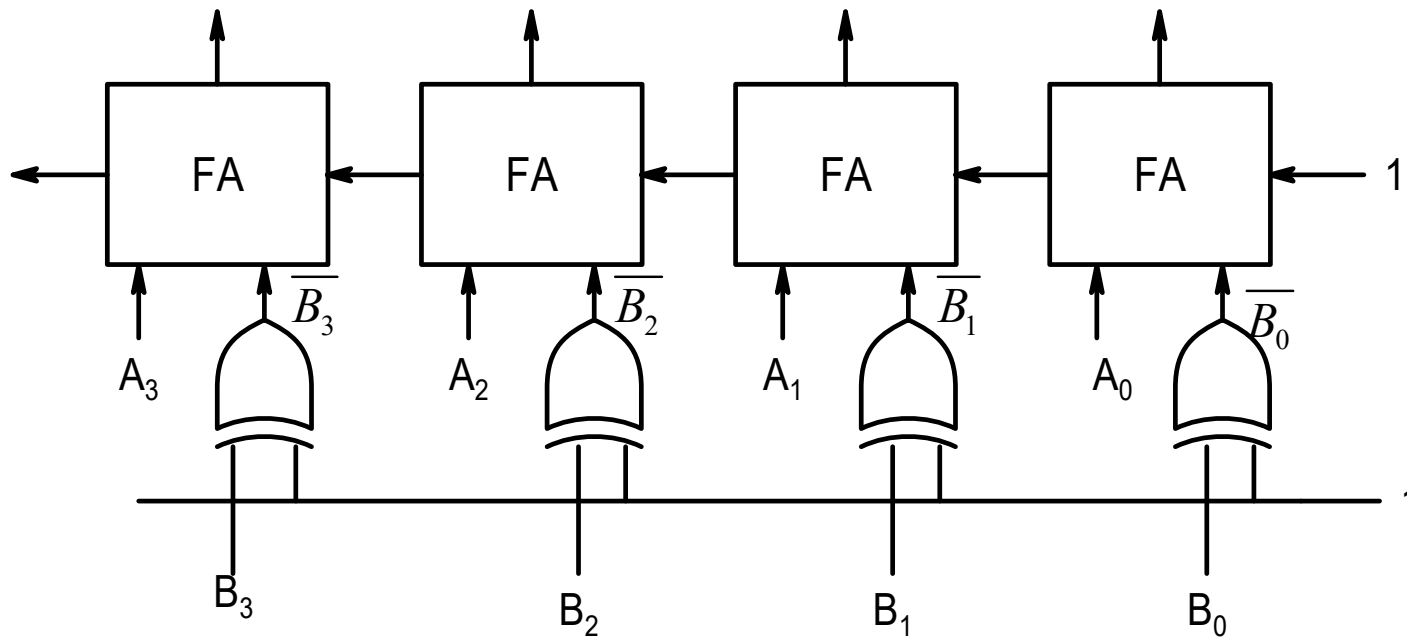
**Ripple Carry Adder (20 gate circuit)**

## Subtraction

$$A - B = A + 2\text{'s complement of } B$$

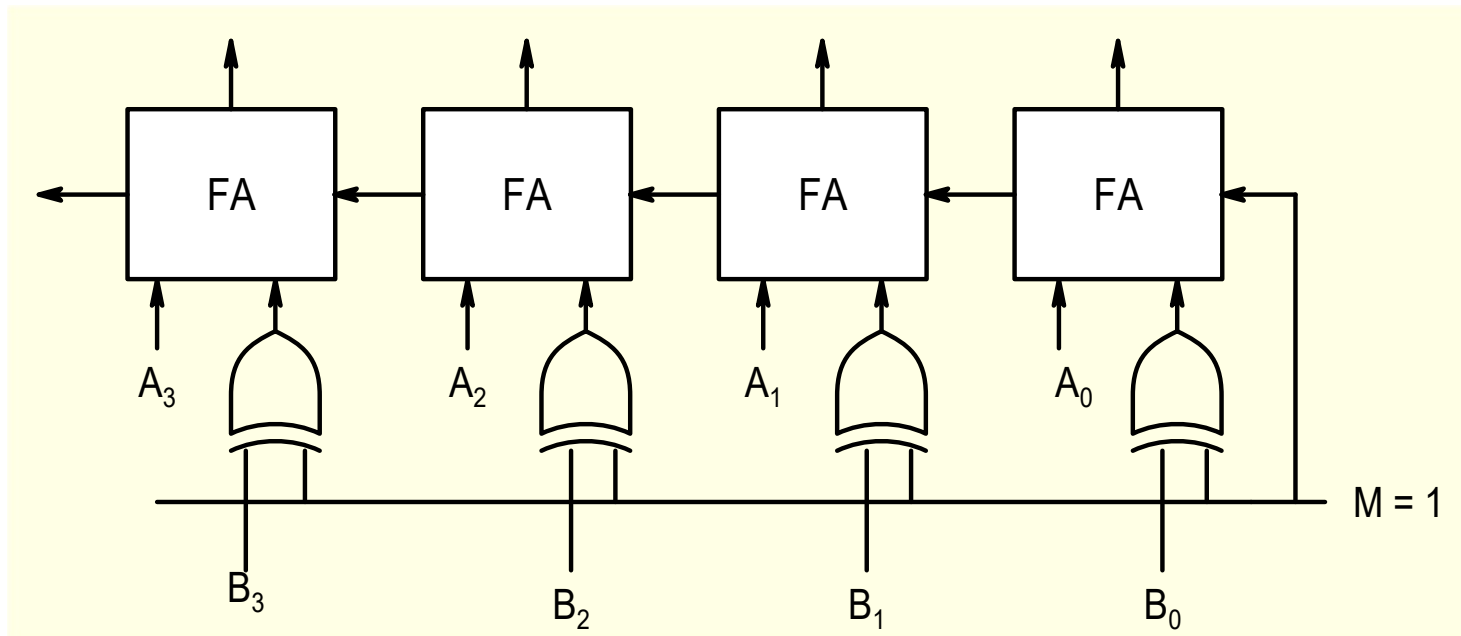
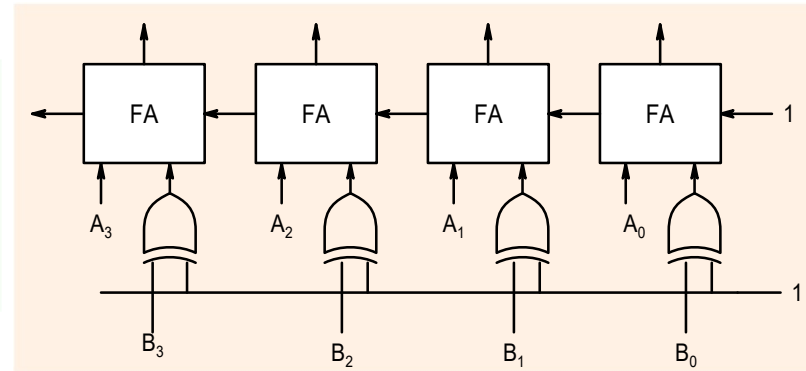
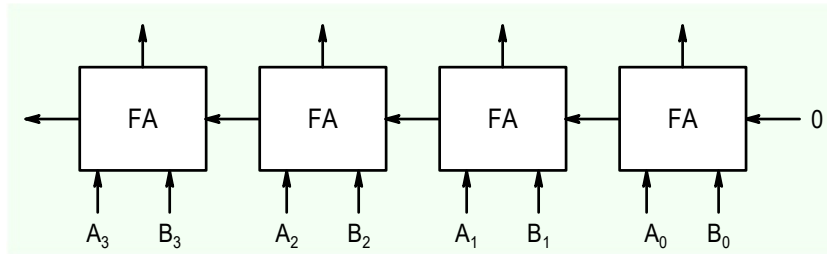
$$A - B = A + 1\text{'s complement of } B + 1$$

$$A - B = A + \overline{B} + 1$$



One needs add a circuit for predicting errors resulting from overflow

## Adder/Subtractor





# Multiplier

